TOTAL MAXIMUM DAILY LOAD FOR TEMPERATURE ON NORTH PONIL CREEK

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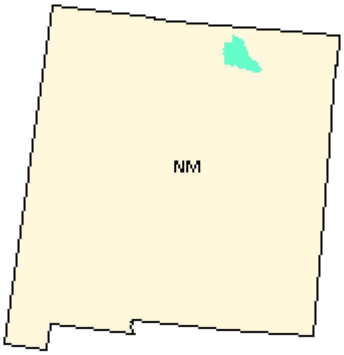
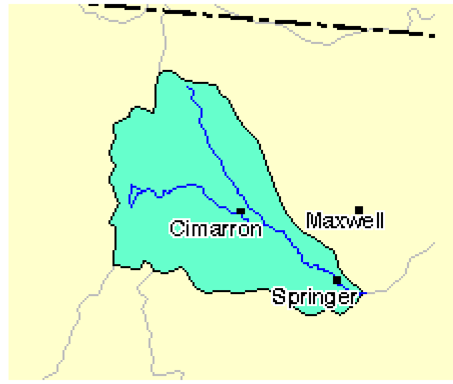
Canadian River Basin (Cimarron)





Summary Table

New Mexico Standards Segment	Canadian River, 2306
Waterbody Identifier	• North Ponil Creek from the confluence with South Ponil Creek to the mouth of M^{c}Crystal Creek (CR2-10400) Total Waterbody Mileage 17.6 miles Total Affected Mileage ≈7-10 linear miles
Parameters of Concern	Temperature
Uses Affected	High Quality Coldwater Fishery
Geographic Location	Canadian River Basin (Cimarron)
Scope/size of Watershed	1,032 mi^2 (Cimarron)/ 90 mi^2 (TMDL area)
Land Type	Ecoregions: Southern Rockies (210, 211)
Land Use/Cover	Forest (94%), Rangeland (6%)
Identified Sources	Removal of Riparian Vegetation, Rangeland, Silviculture
Watershed Ownership	Private (51%), Forest Service (49%)
Priority Ranking	4
Threatened and Endangered Species	None
TMDL for: **Temperature** Upper North Ponil Creek Lower North Ponil Creek	WLA + LA + MOS = 0 + 134.90(joules/meter^2/second/day) + 14.9(joules/meter^2/second/day) = 149.80(joules/meter^2/second/day) WLA + LA + MOS = 0 + 121.70(joules/meter^2/second/day) + 13.5(joules/meter^2/second/day) = 135.20(joules/meter^2/second/day)

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop total maximum daily load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL documents the amount of a pollutant a water body can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources. TMDLs are defined in 40 CFR Part 130 as the sum of the individual Waste Load Allocations (WLA) for point sources and Load Allocations (LA) for nonpoint sources, including a margin of safety and natural background conditions.

The Cimarron River Basin is a sub-basin of the Canadian River Basin, located in northeastern New Mexico. Exceedences of New Mexico water quality standards for temperature were documented on North Ponil Creek from the confluence with Ponil Creek to the mouth of M^c Crystal Creek (17.6 mi.). Over the years, reduced riparian vegetation, including herbaceous woody plants such as willow, narrowleaf cottonwoods and alder along the stream, and exceedences in temperature standards have been seen and documented along this reach of North Ponil Creek. Thermograph (temperature monitoring devices) stations were located on upper North Ponil Creek at Forest Road 1950 and on lower North Ponil Creek above the confluence with Ponil Creek. This monitoring effort documented 44 exceedences out of a total of 1,631 readings on upper North Ponil Creek and 339 exceedences out of a total of 1,632 readings on lower North Ponil Creek of New Mexico water quality standards for temperature at these two sites. This TMDL addresses these exceedences.

A general implementation plan for activities to be established in the watershed is included in this document. The Surface Water Quality Bureau's Nonpoint Source Pollution Section will further develop the details of this plan. Implementation of recommendations in this document will be accomplished with full participation of all interested and affected parties. During implementation, additional water quality data will be generated. As a result targets will be re-examined and potentially revised; this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate or if new standards are adopted, the load capacity will be adjusted accordingly.

LIST OF ABBREVIATIONS

BMP	**best management practice**
CFS	**cubic feet per second**
CMS	**cubic meters per second**
CWA	**Clean Water Act**
CWAP	**Clean Water Action Plan**
CWF	**cold water fishery**
EPA	**Environmental Protection Agency**
HQCWF	**high quality cold water fishery**
LA	**load allocation**
MGD	**million gallons per day**
mg/L	**milligrams per liter**
MOS	**margin of safety**
MOU	**memorandum of understanding**
NMED	**New Mexico Environment Department**
NPDES	**national pollution discharge elimination system**
NPS	**nonpoint sources**
NTU	**nephelometric turbidity units**
SNTEMP	**Stream Network Temperature Model**
SSSHADE	**Solar Shading Model**
SSSOLAR	**Local Solar Radiation Model**
SSTEMP	**Resulting Stream Temperature Model**
SWQB	**Surface Water Quality Bureau**
TMDL	**total maximum daily load**
UWA	**Unified Watershed Assessment**
WLA	**waste load allocation**
WQLS	**water quality limited segment**
NMWQCC	**New Mexico Water Quality Control Commission**
WQS	**water quality standards**

Background Information

North Ponil Creek is located in the Cimarron River Basin, a sub-basin of the Canadian River Basin, located in northeastern New Mexico and is a tributary to Ponil Creek. North Ponil Creek originates as McCrystal Creek and flows southeast for approximately 17.6 miles before it and the Middle Ponil join to form Ponil Creek **(Figures 1 and 2)**. The North Ponil drainage is approximately 90 square miles, with 94 percent being forested and 6 percent rangeland.

In 1996, the United States Forest Service, Carson National Forest removed a fishing pond below McCrystal Creek Campground that had been established some years earlier. It appears that the stream was not restored to its natural geomorphic condition (pre-fishing pond), therefore causing serious erosion, sediment deposition downstream, slumping and streambank destabilization throughout the system. The loss of streambank and thus riparian vegetation (including streamside grasses), increased width-to-depth ratios, and could lead to direct solar gain during the critical summer months. As far back as June 6, 1989 creek temperature exceedences have been documented at this upper site (22.1°C) as well as the lower site on June 5, 7 and 8, 1989 (22.8°, 24.1°C, 23.0° and 20.1°C) respectively.

North Ponil Creek from the confluence with Ponil Creek (listed as South Ponil Creek) to the mouth of McCrystal Creek, is listed in the New Mexico 1998-2000 303(d) list as not supporting its designated use due to temperature exceedences. Thermograph data show that approximately 7-10 miles of the stream are not supporting the designated use due to temperature exceedences. This TMDL is for those 7-10 miles only.

Probable sources of nonsupport include: rangeland activities (grazing), silviculture and removal of riparian vegetation.

Figure 1.

Cimarron Watershed - #11080002
Land Use/Cover

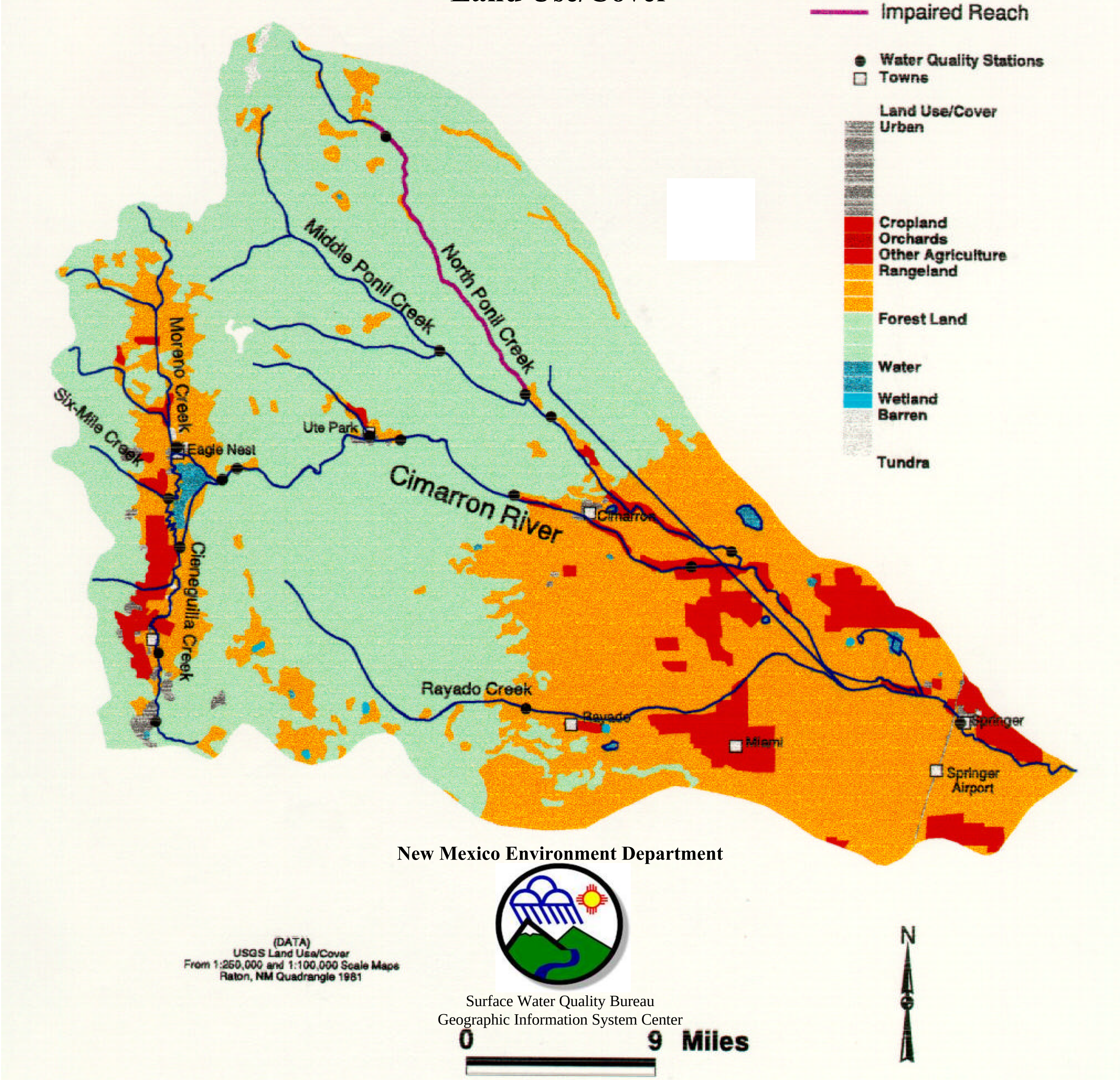
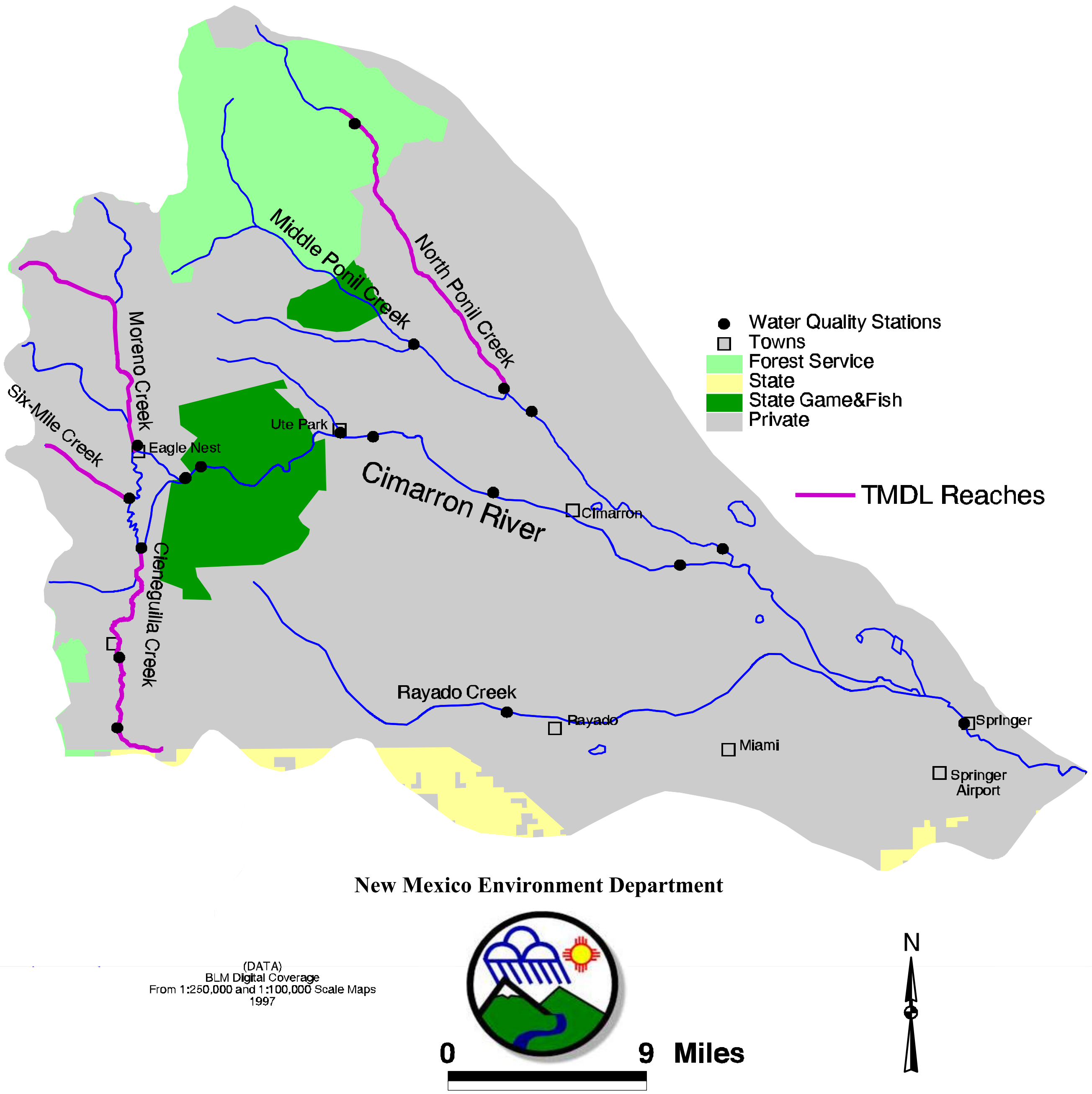


Figure 2. **Cimarron Watershed - #11080002**
Land Ownership



Surface Water Quality Bureau
Geographic Information System Center

Endpoint Identification

Target Loading Capacity

The New Mexico WQCC has adopted numeric water quality standards for temperature to protect the designated use of HQCWF. These water quality standards have been set at a level to protect cold-water aquatic life such as trout. The HQCWF use designation requires that a stream reach must have water quality, stream bed characteristics, and other attributes of habitat sufficient to protect and maintain a propagating coldwater fishery (i.e., a population of reproducing salmonids). The primary standard leading to an assessment of use impairment is the numeric criteria for temperature of 20^{o}C (68^{o}F)[1].

Load Allocations

The Stream Segment and Stream Network Temperature Models[2]

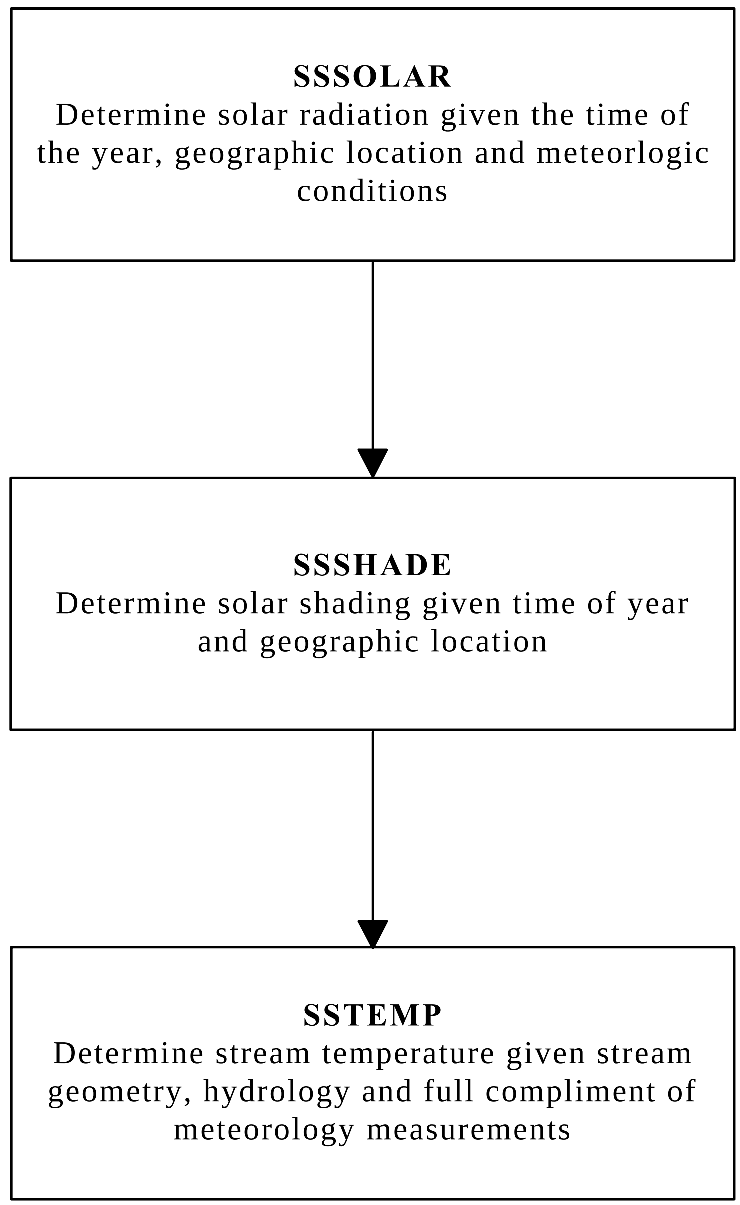
Water temperature can be expressed as heat energy per unit volume. The Stream Segment Temperature Models (SSTEMP) provide an estimate of heat energy per unit volume expressed in Joules (the absolute meter kilogram-second unit of work or energy equal to 10^7 ergs or approximately 0.7375 foot pounds) per meter squared per second (J/M^2/S) and Langleys (a unit of solar radiation equivalent to one gram calorie per square centimeter of irradiated surface) per day.

The SSTEMP programs are currently divided into three related but separable components or submodels. Though technically the programs can be run in any order, for our purposes, we will conceptualize them in a physically based order **(Figure 3)**:

1 **New Mexico Water Quality Control Commission, *State of New Mexico Standards for Interstate and Intrastate Streams(20 NMAC 6.1)*, Subpart I - General, Section 1102 (I), p. 5, Subpart III - Definitions and Standards Applicable to Attainable or Designated Uses, Section 3101(C), p. 44.**

2 **US Geological Survey, Biological Resource Division, Midcontinent Ecological Science Center, River Systems Management Section, Fort Collins, CO, 1997. *The Stream Segment and Stream Temperature Models, Version 1.0*, pp. 35-50**

Figure 3. Model Components



Determining the Local Solar Radiation (SSSOLAR)[3]

To parameterize the model, follow the procedure outlined below:

Beginning Month and Day – Enter the number of the month and day which start the time period of interest.
Ending Month and Day – Enter the number of the month and day which end the time period of interest.
Number of Days – The number of days is a factor which tells the program when and how often to sample during the period. If the results are for a single day only, use one day. For periods between a day and a month, two days is sufficient. Time periods greater than a month are not recommended.
Latitude (degrees and minutes) – Latitude refers to the position of the stream segment on the earth's surface relative to the equator. It may be determined from any standard topographic map. You should enter both degrees and minutes in the spaces provided.
Elevation – Determine mean elevation from the topographic map.
Air Temperature (°F) – Mean daily air temperature representative of the time period modeled.
Relative Humidity (percent) – Mean daily relative humidity representative of the time period modeled.
Possible Sun (percent) – This variable is an indirect measure of cloud cover. Ten percent cloud cover is 90 percent possible sun. Estimates are available from the Weather Service or can be directly measured.
Dust Coefficient – This dimensionless value represents the amount of dust in the air. Representative values are:

Winter	-	6 to 13
Spring	-	5 to 13
Summer	-	3 to 10
Fall	-	4 to 11

If all other variables are known, the dust coefficient may be calibrated by using known ground-level solar radiation data. For the purposes of this model, an intermediate value is sufficient; the model is not very variable sensitive. For example, when modeling summer conditions, entering 6.5 will suffice.
Ground Reflectivity (percent) – The ground reflectivity is a measure of the amount of short wave radiation reflected from the earth back into the atmosphere, and is a function of vegetative cover, snow cover or water. Representative values are:

Meadows and fields	14
Leaf and needle forest	5 to 20

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3 **US Geological Survey, Biological Resource Division, Midcontinent Ecological Science Center, River Systems Management Section, Fort Collins, CO, 1997. *The Stream Segment and Stream Temperature Models, Version 1.0*, pp. 37-39**

Dark, extended mixed forest	4 to 5
Heath	10
Flat ground, grass covered	15 to 33
Flat ground, rock	12 to 15
Flat ground, tilled soil	15 to 30
Sand	10 to 20
Vegetation, early summer	19
Vegetation, late summer	29
Fresh snow	80 to 90
Old snow	60 to 80
Melting snow	40 to 60
Ice	40 to 50
Water	5 to 15

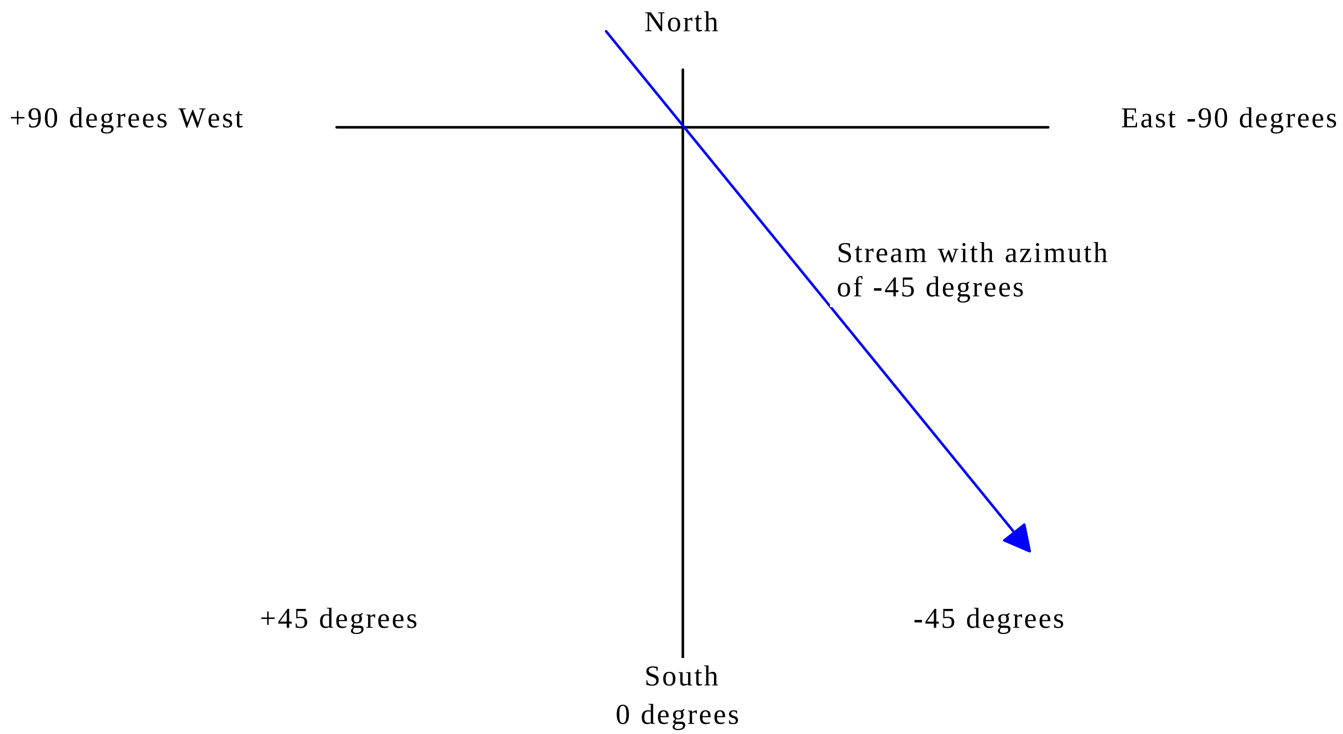
The short wave radiation units are shown in Joules per square meter per second and in Langleys per day. The latter is the common English measurement unit. The values to be carried into **SSTEMP** are the radiation penetrating the water and the daylight hours.

Determining Solar Shading (SSSHADE)[4]

To parameterize the model, follow the procedure outlined below:

Latitude (degrees and minutes) – Latitude refers to the position of the stream segment on the earth's surface relative to the equator. It may be determined from any standard topographic map. You should enter both degrees and minutes in the spaces provided.
Azimuth (degrees) – Azimuth refers to the general orientation of the stream segment with respect to due South and controls the convention of which side of the stream is east or west. A stream running north-south would have an azimuth of 0°. A stream running northwest-southeast would have an azimuth of –45 degrees. The direction of flow does not matter. Refer to the following diagram for guidance:

[4] **US Geological Survey, Biological Resource Division, Midcontinent Ecological Science Center, River Systems Management Section, Fort Collins, CO, 1997. *The Stream Segment and Stream Temperature Models, Version 1.0*, pp. 40-44**



Once the azimuth is determined, usually from the topographic map, the east and west sides are fixed by convention.

Width (feet) – Refer to the average width of the stream from water's edge to water's edge for the appropriate time of the year. Note that the width and vegetative offset should usually be changed in tandem.

Month – Enter the number of the month to be modeled.

Day – Enter the number of the day of the month to be modeled. This program's output is for a single day. To compute an average shade value for a longer period (up to one month) use the middle day of that period. The error will usually be less than one percent.

Topographic Altitude (degrees) – This is a measure of the average incline to the horizon from the middle of the stream. Enter a value for both east and west sides. The altitude may be measured with a clinometer or estimated from topographic maps. In hilly country, topographic maps may suffice.

Vegetative Height (feet) – This is the average height for the shade-producing level of vegetation measured from the water's surface.

Vegetation Crown (feet) – This is the average maximum crown diameter for the shade-producing level of vegetation along the stream.

Vegetation Offset (feet) – This is the average offset of the stems of the shade-producing level of vegetation from the water's edge.

Vegetation Density (percent) – This is the average screening factor (0 to 100%) of the shade-producing level of vegetation along the stream. It is composed of two parts: the continuity of the vegetative coverage along the stream (quantity), and the percent of light filtered by the vegetation's leaves and trunks (quality).

For example, if there is vegetation along 25 percent of the stream and the average density of that coverage is 85 percent, the total vegetative density is 0.25 time 0.85, which equals 0.2125, or 21.25 percent. The value should always be between 0 and 100 percent.

To give examples of shade quality, an open pine stand provides about 65 percent light filtering; a closed pine stand provides about 75 percent light removal; relatively dense willow or deciduous stands remove about 85 percent of the light; a tight spruce/fir stand provides about 95 percent light removal. Areas of extensive, dense emergent vegetation should be considered 90 percent efficient for the surface area covered.

The program will predict the total segment shading for the set of variables you provide. The program will also display how much of the total shade is a result of topography and how much is a result of vegetation. The topographic shade and vegetative shade are added to provide total shade. However, one should think of topographic shade as always being dominant in the sense that topography always intercepts radiation first, then the vegetation intercepts what is left. The value for total segment shade is carried forward into the **SSTEMP** program.

Determine Resulting Stream Temperatures (SSTEMP)[5]

To parameterize the model, follow the procedure outlined below:

Segment Inflow (cfs or cms) – Enter the mean daily flow at the top of the stream segment. If the segment begins at a true headwater, the flow may be entered as zero; all accumulated flow will accrue from lateral (groundwater) inflow. If the segment begins at a reservoir, the flow will be outflow from the reservoir. The model assumes steady-state flow conditions.
Inflow Temperature (°F or °C) – Enter the mean daily water temperature at the top of the segment. If the segment begins at a true headwater, you may enter any water temperature because zero flow has zero heat. If there is a reservoir at the inflow, use the reservoir release temperature. Otherwise, use the outflow temperature from the upstream segment.
Segment Outflow (cfs or cms) – The program calculates the lateral discharge by knowing the flow at the head and tail of the segment, subtracting to obtain the net difference, and dividing by segment length. The program assumes that lateral inflow (or outflow) is uniformly apportioned through the length of the segment. If any "major" tributaries enter the segment, divide the segment into subsections between such tributaries. "Major" is defined as any stream contributing greater than 10 percent of the mainstem flow.
Lateral Temperature (°F or °C) – The temperature of the lateral inflow, barring tributaries, should be the same as the groundwater temperature. In turn, groundwater temperature is often very close to the mean annual air temperature. This can be verified this by checking USGS well log temperatures. Obvious exceptions may arise in areas of geothermal activity. If irrigation return flows make up most of the lateral flow, they may be warmer than mean annual air temperature.

5 **US Geological Survey, Biological Resource Division, Midcontinent Ecological Science Center, River Systems Management Section, Fort Collins, CO, 1997. *The Stream Segment and Stream Temperature Models, Version 1.0*, pp. 44-49**

Return flow temperature may be approximated by equilibrium temperatures.

Segment Length (miles or kilometers) – Enter the length of the segment for which you want to predict the outflow temperature.

Manning's n (dimensionless) – Manning's n is an empirical measure of the stream's "roughness." A generally acceptable default value is 0.035. The variable is necessary only if you are interested in predicting the minimum and maximum daily fluctuation in temperatures. This variable is not used in the prediction of the mean daily water temperature, and the model is not particularly sensitive to it.

Elevation Upstream (feet or meters) – Enter the elevation as taken from a 7-1/2 minute quadrangle map.

Elevation Downstream (feet or meters) - Enter the elevation as taken from a 7-1/2 minute quadrangle topographic map.

Width's A Term (dimensionless) – This variable may be derived by calculating the wetted width versus discharge relationship. To conceptualize this, plot the width of the segment on the Y-axis and discharge on the X-axis. Three or more measurements are much better than two. The relationship should approximate a straight line, the slope of which is the B term. Substitution of the stream's actual wetted width for the A term will result if the B term is equal to zero. This is satisfactory if you will not be varying the flow, and thus the stream width, very much in your simulations. If, however, you will be changing the flow by a factor of 10 or so, you should go to the trouble of calculating the A and B terms more precisely.

Width's B Term (dimensionless) – The B term is calculated by linear measurements from the above mentioned plot. A good estimate in the absence of anything better is 0.20 (Leopold, 1964).

Thermal Gradient (Joules/Meter^2/Second/°C) – This quantity is a measure of the rate of thermal flux from the streambed to the water. The model is not particularly sensitive to this variable. The default value is 1.65.

Air Temperature (°F or °C) – Enter the mean daily air temperature. This and the following meteorological variables may come from weather reports which can be obtained for a weather station near the site.

Relative Humidity (percent) – Obtain the mean daily relative humidity for the area by measurement or from the weather service.

Wind Speed (miles/hour or meters/second) – Measure or obtain from the Weather Service.

Percent Possible Sun (percent) – This variable is an indirect measure of cloud cover. Ten percent cloud cover is 90 percent possible sun. Estimates are available from the Weather Service or can be directly measured.

Solar Radiation (Langleys/day or Joules/meter^2/second) – Enter the results from the **SSSOLAR** program. If you use a source other than SSSOLAR (such as Cinquemani 1978), you should assume that approximately 93 percent of the ground-level solar radiation actually enters the water; the rest is assumed to be reflected. Thus, multiply any recorded ground-level solar measurements by 0.93 to calculate the radiation actually entering the water.

Daylight Length (hours) – Adjust the time between sunrise and sunset for the time of year. You may use the **SSSOLAR** program to calculate this.

Segment Shading (percent) – This variable refers to how much of the segment is shaded by vegetation, cliffs, etc. If 10 percent of the water surface is shaded, enter 10. To be accurate, the **SSSHADE** model should be used to predict the actual shading value based on topography, vegetative coverage and vegetative density.

In lieu of using the **SSSHADE** model, you may think of the shade factor as being the average percent of water surface shaded throughout the day. In actuality, shade represents the percent of the incoming solar radiation that does not reach the water.

Ground Temperature (°F or °C) – Use mean annual air temperature from the weather service.

Dam at Inflow (Yes = 1 No = 0) – If a reservoir is supplying the inflow, enter a 1, otherwise enter a 0.

The maximum daily water temperature is calculated by following a parcel of water from solar noon at the top of the stream segment to the end of the segment, allowing it to heat up towards the maximum equilibrium temperature. If there is an upstream reservoir or spring that is the source of constant temperature water, and the distance upstream is less than the distance traveled by the water parcel from solar noon to the end of the segment, the water parcel from the dam's discharge is heated instead of the water parcel a full half-day's travel upstream. The stream segment meteorology and geometry supplied as variables will apply to the distance upstream through which the water column travels.

The program will predict the 24-hour minimum, mean and maximum daily water temperature for the set of variables provided. The theoretical basis for the model is strongest for the mean daily temperature. The maximum daily temperature varies as a function of several different factors.
The mean daily equilibrium temperature is that temperature which the mean daily water temperature will approach if all conditions remain the same as the water parcel travels downstream. Of course, all conditions cannot remain the same, since the elevation changes immediately.

The maximum daily equilibrium temperature is that temperature which the maximum daily water temperature will approach.

Other results include the intermediate variables average width, average depth and slope, calculated from the twenty input variables, and the heat flux components. These heat flux components are abbreviated in the program's output as follows:

ATM	=	atmospheric component
CVN	=	convection component
CDN	=	conduction component
EVP	=	evaporation component
FRC	=	friction component
SOL	=	solar radiation component
VEG	=	vegetative radiation component
WAT	=	water's back radiation component

Assumptions and Limitations[6]

There are several assumptions that apply to SNTEMP. These assumptions in turn dictate the limitations in terms of model applications.

First, SNTEMP is a steady state model. It assumes that the conditions being simulated involve only steady flow – no hydropeaking can be simulated unless the flows are essentially constant for the entire averaging period. The minimum average period is one day. Similarly, the boundary conditions of SNTEMP are assumed homogeneous and constant. This has implications for the maximum size of the network simulated for a single averaging period.

Second, SNTEMP assumes homogeneous and instantaneous mixing wherever two sources of water are combined. There is no lateral or vertical temperature distribution (or dispersion/diffusion), represented in the model.

Third, SNTEMP itself is meant solely for stream temperature predictions. It will not handle stratified reservoirs, though river-run reservoirs with equilibrium releases may be simulated.

Fourth, SNTEMP is not a hydrology model. It should be relied on to distribute flows in an ungaged network. That is often an additional, non-temperature model task.

Fifth, SNTEMP may not be reliable in very cold conditions, i.e., water temperatures less than 4°C. It is not meant for ice or the like.

Finally, SNTEMP and SSTEMP have been tested only in the northern hemisphere.

Temperature Allocations as Determined by Percent (%) Shade

The following tables show outputs of the three-month model run from June 1 through August 31 on Upper North Ponil Creek and Lower North Ponil Creek respectively. As the percent total shade is increased, the maximum 24-hour temperature decreases until the HQCWF standard (20°C, 68°F) is achieved. On Upper North Ponil Creek, this occurs when the percent total shade of the model is 55 and higher. The actual load allocation (LA) of 134.9 joules/meter^2/second is achieved at 60 percent shade or higher according to the model runs. On Lower North Ponil Creek, this occurs when the percent total shade of the model is 59 and higher. The actual load allocation (LA) of 121.7 joules/meter^2/second is achieved at 64 percent shade or higher according to the model runs.

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6 **US Geological Survey, Biological Resource Division, Midcontinent Ecological Science Center, River Systems Management Section, Fort Collins, CO, 1997. *The Stream Segment and Stream Temperature Models, Version 1.0*, pp. 26-27**

Three Month Summer Model Run On Upper North Ponil Creek

<table>
<tr><th>Rosgen Channel Class</th><th>WQS (HQCWF)</th><th>Model Run Dates</th><th>Segment Length (mi)</th><th>Solar Radiation Component per 24 - Hours (+/-)</th><th>% Total Shade</th><th>% Topo Shade</th><th>% Veg Shade</th><th>Temperature (24 hour) °F</th><th>Temperature (24 hour) °C</th></tr>
<tr><td>E5 Stream Type</td><td>20° C (68° F)</td><td>June 1 thru Aug 31</td><td>5</td><td>Current Field Condition +229.7 joules/meter²/ second</td><td>31</td><td>8</td><td>24</td><td>Minimum 52.33
Mean 62.91
Maximum 73.48</td><td>Minimum 11.29
Mean 17.17
Maximum 23.04</td></tr>
<tr><td colspan="4" rowspan="4">Stream Segment Temperature Model (SSTEMP)

TEMPERATURE ALLOCATIONS AS DETERMINED BY % SHADE ON UPPER PONIL CREEK

DENOTES 24 HOUR ACHIEVEMENT OF SURFACE WATER QUALITY STANDARD FOR TEMPERATURE

Actual Reduction in Solar Load to this Stream to meet the State surface water quality standard is:

229.70 joules/meter²/second (current condition) - 134.90 joules/meter²/second (60% shaded water)
94.80 joules/meter²/second

# Denotes the achievement of the 134.9 joules/meter²/second load allocation (LA)</td><td>+189.8 joules/meter²/second</td><td>43</td><td>8</td><td>35</td><td>Minimum 51.73
Mean 61.25
Maximum 70.77</td><td>Minimum 10.96
Mean 16.25
Maximum 21.54</td></tr>
<tr><td>+153.1 joules/meter²/second</td><td>54</td><td>8</td><td>46</td><td>Minimum 51.24
Mean 59.69
Maximum 68.14</td><td>Minimum 10.69
Mean 15.38
Maximum 20.08</td></tr>
<tr><td>*+149.8 joules/meter²/second</td><td>55</td><td>8</td><td>47</td><td>Minimum 51.20
Mean 59.54
Maximum 67.89</td><td>Minimum 10.67
Mean 15.30
Maximum 19.94</td></tr>
<tr><td>#+134.9 joules/meter²/second</td><td>60</td><td>8</td><td>52</td><td>Minimum 50.99
Mean 58.81
Maximum 66.63</td><td>Minimum 10.55
Mean 14.89
Maximum 19.24</td></tr>
</table>

Three Month Summer Model Run On Lower North Ponil Creek

<table>
<tr><th>Rosge,n Channel Class</th><th>WQS (HQCWF)</th><th>Model Run Dates</th><th>Segment Length (mi)</th><th>Solar Radiation Component per 24 - Hours (+/-)</th><th>% Total Shade</th><th>% Topo Shade</th><th>% Veg Shade</th><th>Temperature ^{o}F (24 hour)</th><th>Temperature ^{o}C (24 hour)</th></tr>
<tr><td>E4 Stream Type</td><td>200C (68^{o} F)</td><td>June I thru Aug 31</td><td>5</td><td>Current Field Condition +211.0 joules/meter^2/ second</td><td>36</td><td>27</td><td>9</td><td>Minimum 52.68
Mean 62.93
Maximum 73.18</td><td>Minimum 11.49
Mean 17.18
Maximum 22.88</td></tr>
<tr><td colspan="4" rowspan="6">Stream Segment Temperature Model (SSTEMP)

TEMPERATURE ALLOCATIONS AS DETERMINED BY % SHADE ON LOWER PONIL CREEK

* DENOTES 24 HOUR ACHIEVEMENT OF SURFACE WATER QUALITY STANDARD FOR TEMPERATURE

Actual Reduction in Solar Load to this Stream to meet the State surface water quality standard is:

211.00 joules/meter^2/second (current condition) - 121.70 joules/meter^2/second (64% shaded water)
=
89.30 joules/meter^2/second

# Denotes the achievement of the 121.7 joules/meter^2/second load allocation (LA)</td><td>+197.8 joules/meter^2/second</td><td>40</td><td>27</td><td>13</td><td>Minimum 52.55
Mean 62.43
Maximum 72.30</td><td>Minimum 11.42
Mean 16.91
Maximum 22.38</td></tr>
<tr><td>+181.3 joules/meter^2/second</td><td>45</td><td>27</td><td>18</td><td>Minimum 52.40
Mean 61.79
Maximum 71.19</td><td>Minimum 11.33
Mean 16.55
Maximum 21.77</td></tr>
<tr><td>+164.8 joules/meter^2/second</td><td>50</td><td>27</td><td>23</td><td>Minimum 52.27
Mean 61.16
Maximum 70.04</td><td>Minimum 11.26
Mean 16.20
Maximum 21.13</td></tr>
<tr><td>+148.3 joules/meter^2/second</td><td>55</td><td>27</td><td>28</td><td>Minimum 52.15
Mean 60.51
Maximum 68.87</td><td>Minimum 11.19
Mean 15.84
Maximum 20.48</td></tr>
<tr><td>*+135.2 joules/meter^2/second</td><td>59</td><td>27</td><td>32</td><td>Minimum 52.07
Mean 59.99
Maximum 67.90</td><td>Minimum 11.15
Mean 15.55
Maximum 19.94</td></tr>
<tr><td>#+121.7 joules/meter^2/second</td><td>64</td><td>27</td><td>37</td><td>Minimum 51.98
Mean 59.33
Maximum 66.68</td><td>Minimum 11.10
Mean 15.17
Maximum 19.27</td></tr>
</table>

Link Between Water Quality and Pollutant Sources

Decreased effective shade levels result from reduction of riparian vegetation. This leads to increased incident solar radiation on the water surface and therefore increased energy loading. Wider stream channels also increase the stream surface area exposed to sunlight and heat transfer. Riparian area and channel morphology disturbances are attributed to past, and to some extent current, rangeland grazing practices which have resulted in reduction of riparian vegetation and streambank destabilization. These nonpoint sources of pollution primarily affect the water quality parameter temperature through increased solar loading by: (1) increasing stream surface solar radiation and loading and (2) increasing stream surface area exposed to solar radiation loading. **(Figure 4)**

Riparian vegetation, stream morphology, hydrology, climate and geographic location and aspect influence stream temperature.

Although climate and geographic location and aspect are outside of human control, the condition of the riparian area, channel morphology and hydrology can be affected by land use activities.

Specifically, the elevated summertime stream temperatures attributable to anthropogenic causes in the Cimarron River Basin result from the following conditions:

1. Channel widening (increased width to depth ratios) increases the stream surface area exposed to incident solar radiation,
2. Riparian vegetation disturbance reduces stream surface shading, riparian vegetation height and density,
3. Reduced summertime base flows. Base flows are maintained with a functioning riparian system so that loss of riparian will lower and sometimes eliminate base flows.

Analyses presented in this TMDL will demonstrate that defined loading capacities will ensure attainment of State water quality standards.

Specifically, the relationship between shade, solar radiation, and water quality attainment will be demonstrated. Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events.

Margin of Safety (MOS)

The federal Clean Water Act (CWA) requires that each TMDL be calculated with a margin of safety (MOS). This statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality.

A MOS may be expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions).

The MOS may be implicit, utilizing conservative assumptions for calculation of the loading capacity, WLAs and LAs. The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation.

In the development of this temperature TMDL, the following conservative assumptions were used to parameterize the model:

- Warmest time of the year was used in the modeling due to the seasonality of temperature exceedences (June 1 through August 31).

  The average 1998 monthly ambient air temperatures for June, July and August

  An upstream thermograph was deployed to document the mean daily water temperature above the project site

  Actual elevation and latitude/longitude were determined by using a global positioning system (GPS) at the site

- Critical upstream and downstream low flows were used due to the decreased assimilative capacity of the stream to absorb and disperse solar heat at these flows

  Low flow was modeled using two formulas developed by the USGS. One formula (Waltemeyer 1987) is recommended when the ratio between the two watershed areas is between 0.5 and 1.5. The other formula, to be used when the watershed ratio is outside this range, is a regression formula also developed by the USGS (Borland 1970).

- Stream channel geomorphology was used to determine the level of functionality of the stream along with other physical field measurements that were used in the modeling process

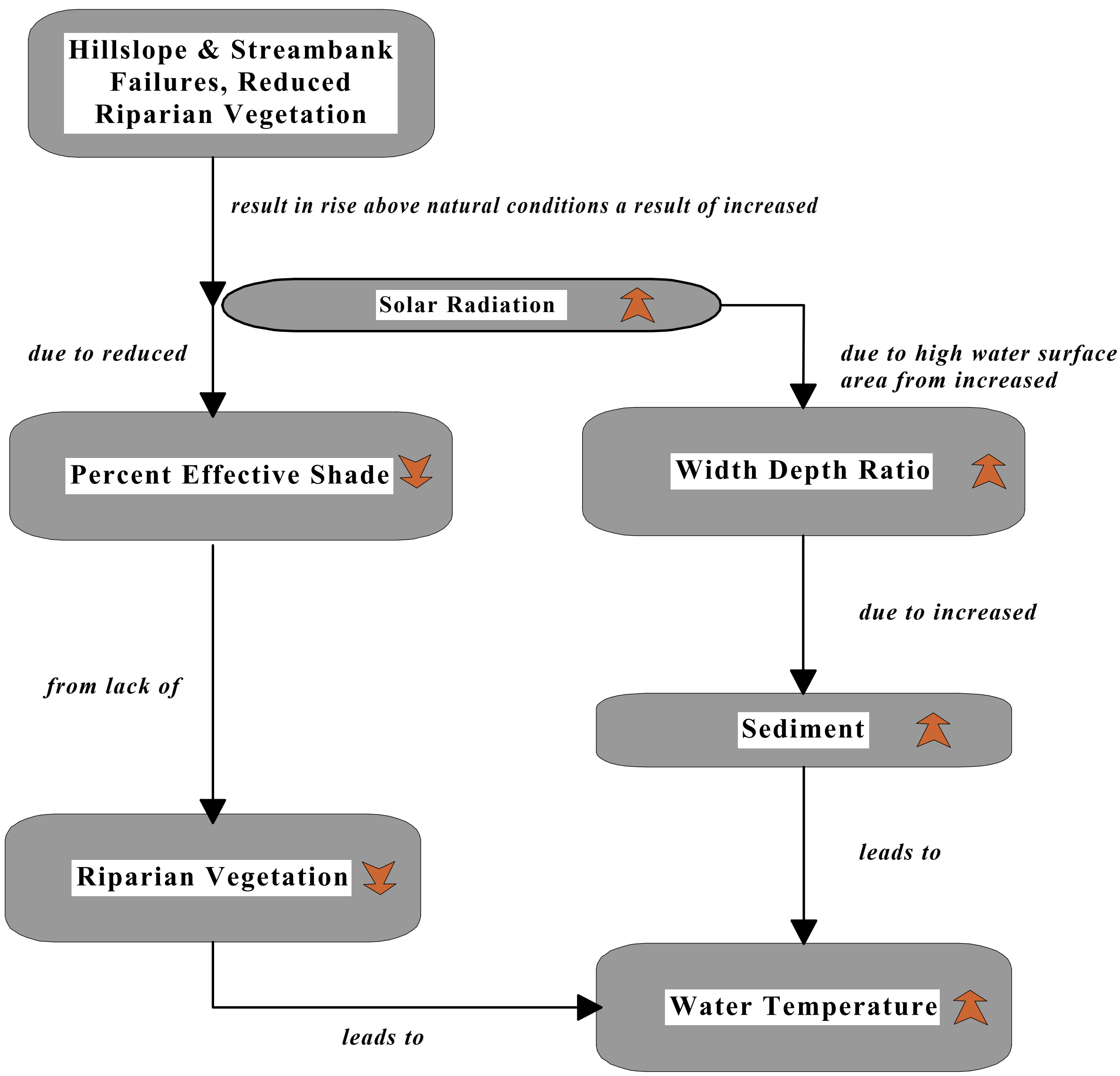
  Actual wetted-width of the stream was used

  Actual stream channel type was characterized as a “E” channel

- Response of receiving waters under various allocation scenarios

  Different shading scenarios were used to show the decease in water temperatures at the critical low flow (see tables)

Figure 4. Factors that Impact Water Temperature



- Expression of analysis results in ranges

  Analysis results provide a range of temperature outputs (see tables)

  Because of the high quality of data and information that was put into this model and the continuous field monitoring data used to verify these model outputs, an explicit MOS of 10 percent is assigned to this TMDL.

Consideration of Seasonal Variation

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable water quality standard with seasonal variation". Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in winter and early spring months.

Thermograph records show that temperatures exceed State water quality standards in summer and early fall on North Ponil Creek. Warmest stream temperatures corresponded to prolonged solar radiation exposure, warm air temperature and low flow conditions. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures.

Monitoring Plan

Pursuant to Section 106(e)(1) of the CWA, the SWQB has established appropriate monitoring methods, systems and procedures in order to compile and analyze data on the quality of the waters of New Mexico. In accordance with the New Mexico Water Quality Act, the SWQB has developed and implemented a comprehensive water quality monitoring strategy for the surface waters of the State. The monitoring strategy establishes the methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of controls and to conduct water quality assessments.

In order to optimize the efficiency of this monitoring effort necessary to support the development of TMDLs, the SWQB has adopted a rotating-basin monitoring strategy.

This strategy selects a number of watersheds which are intensively monitored each year with an established return frequency. The actual watersheds monitored in any given year will be determined as a function of the priorities specified below.

Current priorities for monitoring in the SWQB are determined by utilizing the following documents:

- §303(d) consent decree (***Forest Guardians and Southwest Environmental Center v. Carol Browner, Administrator, U.S. Environmental Protection Agency***, Civil Action No. 96-0826 LH/LFG)
- §303(d) settlement agreement MOU
- Clean Water Action Plan (CWAP) which includes the Unified Watershed Assessment (UWA)

Short-term efforts will be directed toward those waters which are on the EPA TMDL consent decree list and which are due within the first two years of the consent decree schedule. Once assessment monitoring is completed those reaches still showing impacts and requiring a TMDL will be targeted for more intensive monitoring. Methods of data acquisition include fixed-station monitoring, intensive surveys of priority water bodies including biological assessments, and compliance monitoring of industrial, federal and municipal dischargers.

Long term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the waterbody and which can be revisited every five years.

This information will provide time relevant information for use in 305(b) assessments and to support the need for developing TMDLs. The approach provides:

- an unbiased assessment of the waterbody and establishes a long term monitoring record for trend analyses.
- a systematic, detailed review of water quality data and allows for a more efficient use of resources.

- information at a scale useful to the implementation of corrective activities.
- an established order of rotation and predictable sampling in each basin. This allows easier coordination efforts with other programs and water quality entities.
- Enhanced program efficiency and improved basis for management decisions.

It should be noted that a basin will not be ignored during its four-year intensive sampling hiatus. The sampling program is supplemented with other data collection efforts which are classified as field studies. The four-year interim will be used to analyze data, conduct field studies to further characterize identified problems, and develop TMDLs and implement corrective actions. Both types of monitoring, long term and field studies, contribute to the 305(b) report and 303(d) listing processes.

The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document "***Quality Assurance Project Plan for Water Quality Management Programs***" is updated and certified annually by US EPA Region 6. In addition, the SWQB identifies the data quality objectives required to provide information of sufficient quality to meet the established goals of the program.

The following draft schedule for sampling seasons through 2002 will be done in a consistent manner to support the New Mexico Unified Watershed Assessment (UWA) and the Nonpoint Source Management Program. This sampling regime will reflect seasonal variation and includes sampling in spring, summer, and fall for each of the watersheds.

1998 - Jemez River, Chama River (above El Vado Reservoir), Cimarron River (above Springer), Santa Fe River, San Francisco River
1999 - Chama River (below El Vado Reservoir), Middle Rio Grande River , Gila River Watershed, Red River Watershed
2000 - Mimbres River Basin, Dry Cimarron River Basin, Upper Pecos River (Ft. Sumner to headwaters), Upper Rio Grande River (1)
2001 - Upper Rio Grande River (2), Lower Pecos River (Roswell south), Closed Basins, Zuni River Watershed
2002 - Canadian River Basin, Lower Rio Grande River, San Juan River Basin, Rio Puerco Watershed

Implementation Plan

Management Measures

Management measures are "economically achievable measures for the control of the addition of pollutants from existing and new categories and classes of nonpoint sources of pollution, which reflect the greatest degree of pollutant reduction achievable through the application of the best available nonpoint pollution control practices, technologies, processes, siting criteria, operating methods, or other alternatives" (USEPA, 1993). A combination of best management practices (BMPs) will be used to implement this TMDL. Stakeholder and public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholder participation will include both choosing and installing BMPs, as well as participation in volunteer monitoring.

Implementation of this TMDL will consist of three main phases:

1. Temperature baseline verification monitoring
2. BMP implementation
3. Effectiveness monitoring

1. Temperature Baseline Verification Monitoring

Temperature baseline verification monitoring began July 17, 1998 and ran until September 23, 1998. Thermographs were set to read every hour in order to document diurnal fluctuations in the system. Thermographs were re-deployed beginning May 12, 1999 and will be left in place until early September 1999 to continue temperature data collection. This verification monitoring consists of baseline data collection, verification of current conditions including identification of priority sites for BMP implementation and identification of monitoring locations which will be necessary in order to accurately measure improvements.

SWQB has conducted the following baseline verification monitoring activities as part of this phase:

- Establishment of photo documentation points
- Establishment of monitoring sites
- Collection of baseline data including water chemistry, TDS TSS, turbidity, DO, anion/cation, conductivity, temperature, canopy density (stream shade), cross channel profiles, pebble count, percent fines and embeddedness.

Once baseline verification monitoring has been completed, the BMP implementation phase will begin.

2. Potential North Ponil Creek Project BMPs and their Anticipated Contribution to Load Reduction

1) **Riparian Revegetation (plantings)**
Increased canopy cover, stream shade and streambank soil stability. Decreased peak water temperatures, decreased width to depth ratios, a trend toward aggradation of the channel and stream access to the floodplain. Riparian Plantings will consist of native willow, Coyote Willow (*Salix exigua)*, Black Willow *(Salix gooddingii*), Narrowleaf Cottonwood (*Populus angustifolia*) and Alder (*Alnus tenuifolia*) plantings or containerized stock.

2) **Riparian Fencing**
Protection for heavily impacted areas and/or newly rehabilitated segments. Increased revegetation success and streambank soil stability. Decreased TSS and turbidity.

3) **Streambank Modification/Channel Reconstruction**
Accelerated healing of banks, restoration of sinuosity patterns, reduced erosion and sedimentation originating from raw streambanks.

This project on North Ponil Creek will potentially result in approximately 7-10 linear miles of revegetation. Final priorities concerning riparian fencing, streambank/channel modification will be made following baseline verification monitoring. SWQB will encourage public/private land owners and volunteers to become involved and assist in all phases of the implementation process.

3. BMP Effectiveness Monitoring

The currently approved QAPP and Nonpoint Source (NPS) Standard Operating Procedures (SOP) methods will be used for all sampling and monitoring for this project. In order to estimate BMP effectiveness, monitoring efforts will focus on the appropriate physical components of the stream system.

The following physical parameters will be monitored in order to evaluate the effectiveness of BMP's:

- **Cross Channel Profiles**
  These profiles will be established in key locations to measure changes in channel morphology and width:depth ratios. Natural stream channel stability is achieved by allowing the river to develop a stable dimension, pattern and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades.

- **Riparian Canopy Densities**
  Density will be measured at fixed locations to determine quantifiable differences in stream shade.
- **Photo Documentation Points**
  Photographs will be used to evaluate the success of revegetation efforts and to document changes in channel morphology.

It is recognized that measurable changes in these parameters will require some time occur. Accordingly, monitoring activities will continue until changes in the temperature of this reach North Ponil Creek have demonstrated the effectiveness of the BMPs.

Time Line

Implementation Action	Year 1	Year 2	Year 3	Year 4	Year 5
Public Outreach and Involvement	X	X	X	X	X
Establish Milestones	X				
Secure Funding	X		X		
Implement Management Measures (BMPs)		X	X		
Monitor BMPs		X	X	X	
Determine BMP Effectiveness				X	X
Re-evaluate Milestones				X	X

Assurances

New Mexico's Water Quality Act does not contain enforceable prohibitions directly applicable to nonpoint sources of pollution. The Act does authorize the Water Quality Control Commission to "promulgate and publish regulations to prevent or abate water pollution in the state" and to require permits. Several statutory provisions on nuisance law could also be applied to nonpoint source water pollution. The Water Quality Act (20 NMAC 6.2) (NMWQCC 1995a) also states in §74-6-12(a):

> *The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, the State of New Mexico Surface Water Quality Standards (see Section 1100E and Section 1105C) (NMWQCC 1995b) states:

> *These water quality standards do not grant the Commission or any other entity the power to create, take away or modify property rights in water.*

New Mexico policies are in accordance with the federal Clean Water Act §101(g):

> *It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.*

Nonpoint source water quality improvement work utilizes a voluntary approach. This provides technical support and grant money for the implementation of best management practices and other NPS prevention mechanisms through §319 of the Clean Water Act. Since this TMDL will be implemented through NPS control mechanisms the New Mexico Nonpoint Source Program is targeting efforts to this and other watersheds with TMDLs. The Nonpoint Source Program coordinates with the Nonpoint Source Taskforce. The Nonpoint Source Taskforce is the New Mexico statewide focus group representing federal and state agencies, local governments, tribes and pueblos, soil and water conservation districts, environmental organizations, industry, and the public.

This group meets on a quarterly basis to provide input on the Section 319 program process, to disseminate information to other stakeholders and the public regarding nonpoint source issues, to identify complementary programs and sources of funding, and to help review and rank Section 319 proposals. In order to ensure reasonable assurances for implementation in watersheds with multiple landowners, including Federal, State and private land, NMED has established MOUs with different Federal agencies, in particular the Forest Service and the Bureau of Land Management. MOUs have also been developed with other State agencies, such as the New Mexico Highway Department. These MOUs provide for coordination and consistency in dealing with nonpoint source issues.

New Mexico's Clean Water Action Plan has been developed in a coordinated manner with the State's 303(d) process.

All Category I watersheds identified in New Mexico's Unified Watershed Assessment process are totally coincident with the impaired waters list for 1996 and 1998 approved by EPA. The State has given a high priority for funding assessment and restoration activities to these watersheds.

The time required to attain standards in this case is estimated to be 10 years. Standards attainment is predicated on the following growth rates of the riparian species as follows:

Plant Species	**Predicted Time to Maturity (years)**
Coyote Willow *(Salix exigua*)	1-3
Black Willow *(Salix gooddingii)*	1-3
Alder *(Alnus tenuifolia)*	3-5
Narrowleaf Cottonwood *(Populus angustifolia*)	7-10

Milestones

Milestones will be used for determining if BMP's are being implemented and standards attained. For this TMDL several milestones will be established as follows:

Education/Outreach Milestone

Implement outreach programs for schools, educators, citizens, government officials, landowners, land managers, resource professionals and agency representatives.

Grazing/Rangeland Milestones
Demonstrate rotational grazing and other grazing/wildlife management systems. Implement projects on federal, State and private lands for riparian restoration with improved grazing/wildlife management.

Agriculture Milestones
Implement erosion control BMPs.

Measures of Success:

- Improved bank stability and vegetation stability by increasing root systems thus decreasing sediment inputs into the system and improving canopy densities. Measurement tools include but are not limited to pebble counts, embeddedness, % fines, canopy densities and root density estimates.
- Increased stream shade. Measurement tool spherical densiometer readings.
- Measurable reductions in TSS and peak turbidity. Measurement tools include but are not limited to pebble counts, embeddedness, % fines, turbidity readings and lab analyses.
- Increased interagency cooperation via communications with the land management agencies, soliciting their input into the process.
- Increased public participation via pre-monitoring and post-monitoring meetings.

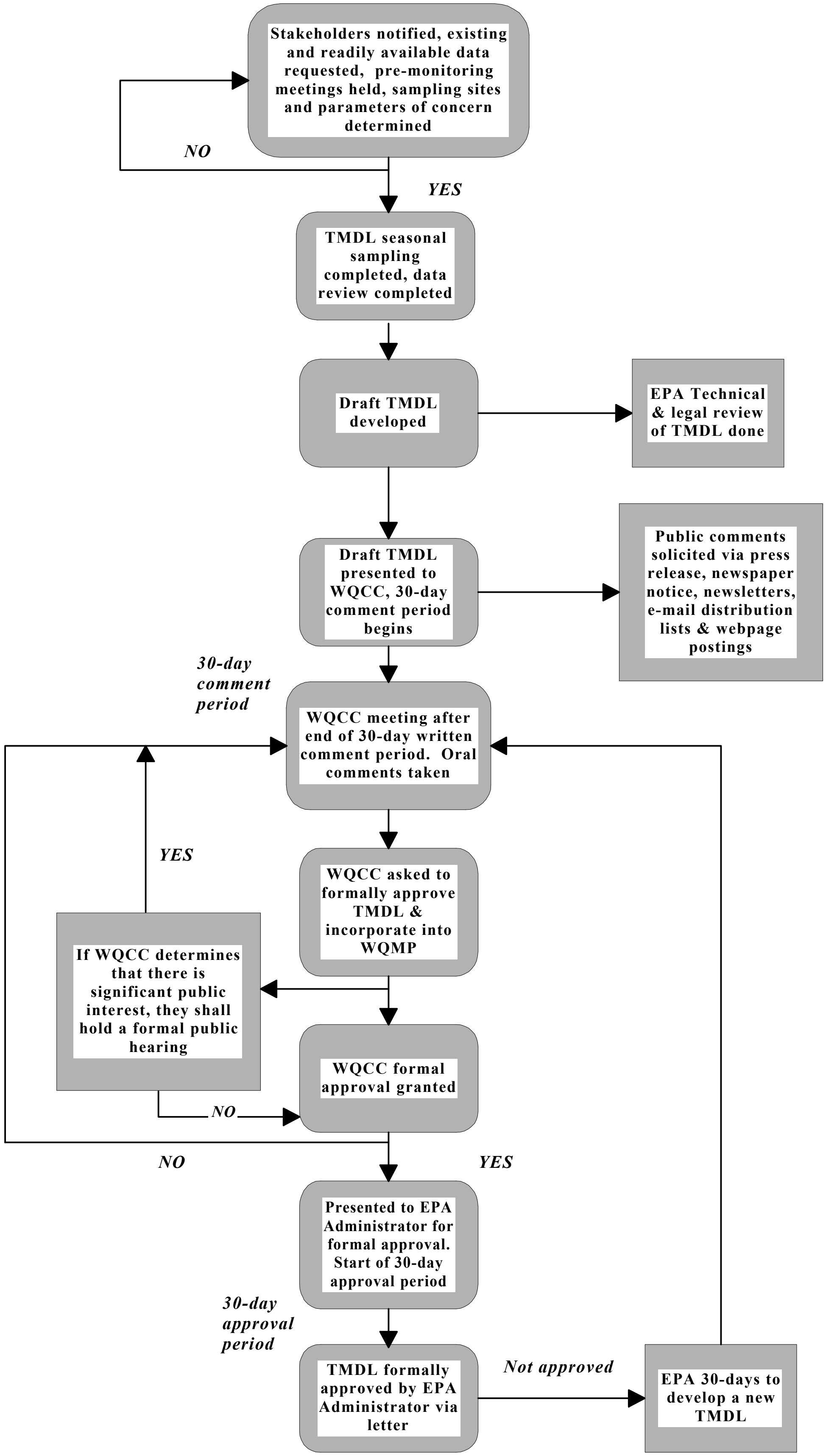
Expanded water quality database and understanding of the relationships between traditional management activities and NPS pollution.

- Increased interagency agreement in determining BMP application and suitability.
- Appropriateness of milestones will be re-evaluated periodically, depending on the BMPs that were implemented. Further implementation of this TMDL will be revised based on this re-evaluation.

Public Participation

The purpose of public participation is to involve all of the interested stakeholders from the start of the process. This requires the sharing of results from the sampling efforts and an indication of what TMDLs will be necessary, along with the implementation plans of these TMDLs (**Figure 5**). Public comments and responses can be found in ***Appendix D*** of this document. The draft document notice of availability was extensively advertised via newsletters, email distribution lists, webpage postings (**http://www.nmenv.state.nm.us**), and press releases to area newspapers.

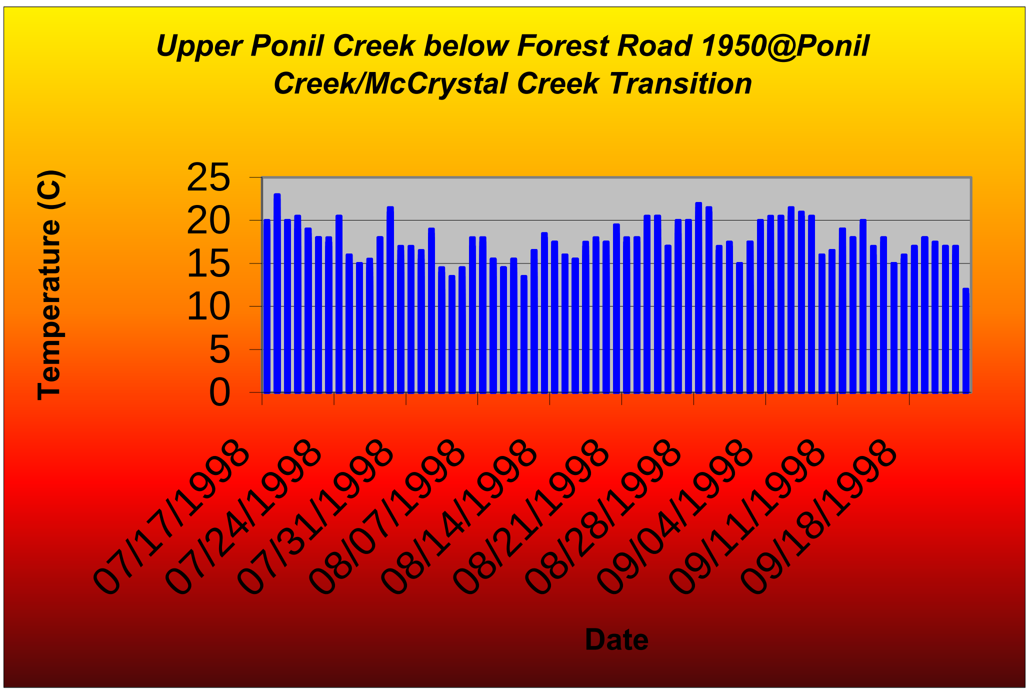
Figure 5. Public Participation Flowchart



Appendix A Thermograph/Geomorphological Data and Sites

Upper North Ponil Thermograph Data

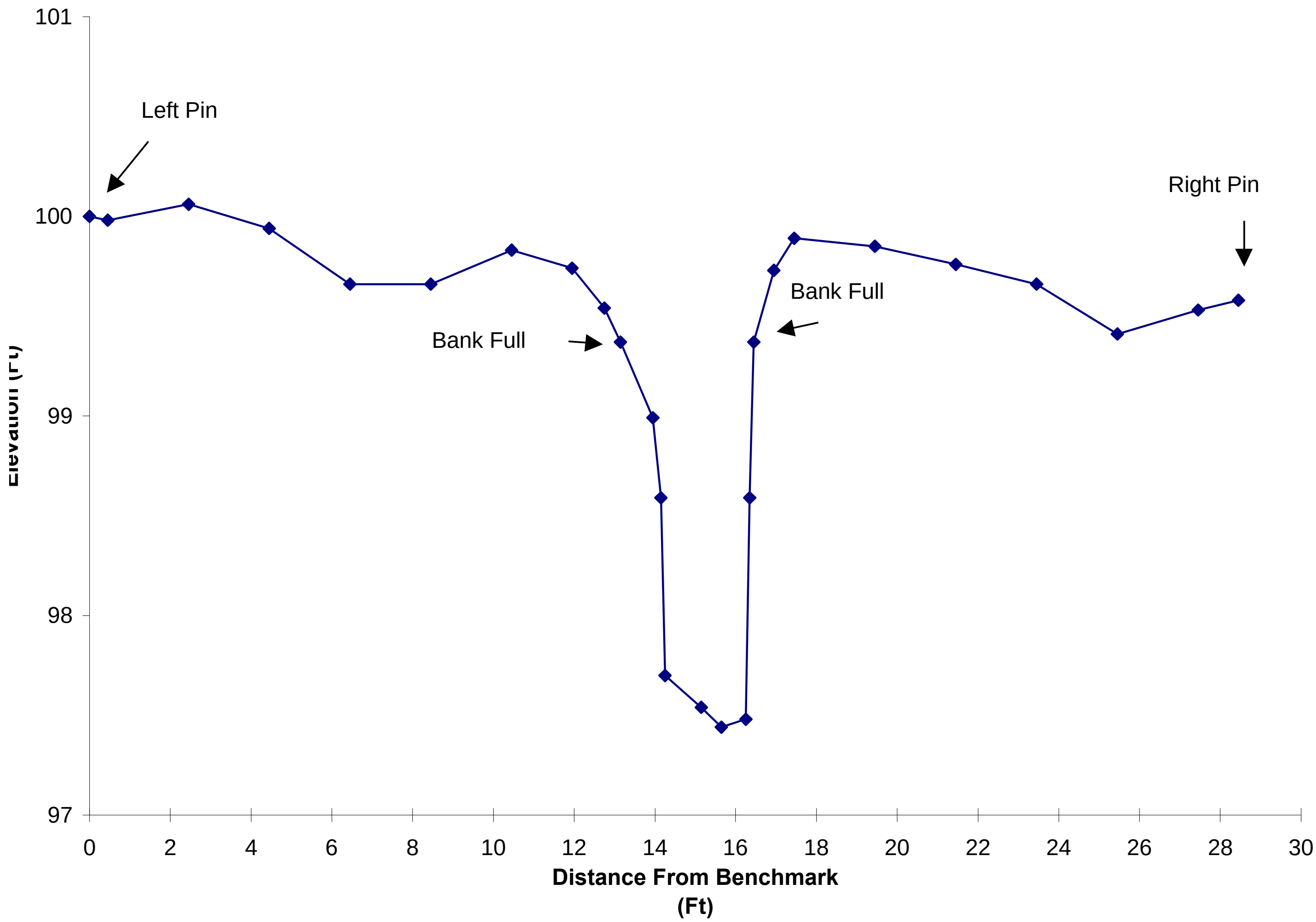
Total Readings	1631
Max .Temp.	23
# Values >20	***44***
% Values >20	***2.7***
Avg. Temp.	14.2
Min. Temp.	6.5
Variance	9.1



Each bar on the graph represents the 24-hour maximum temperature on each day, not the entire data set of 1,631 (i.e. 23°C on 7/18/98).

Upper North Ponil Thermograph Site

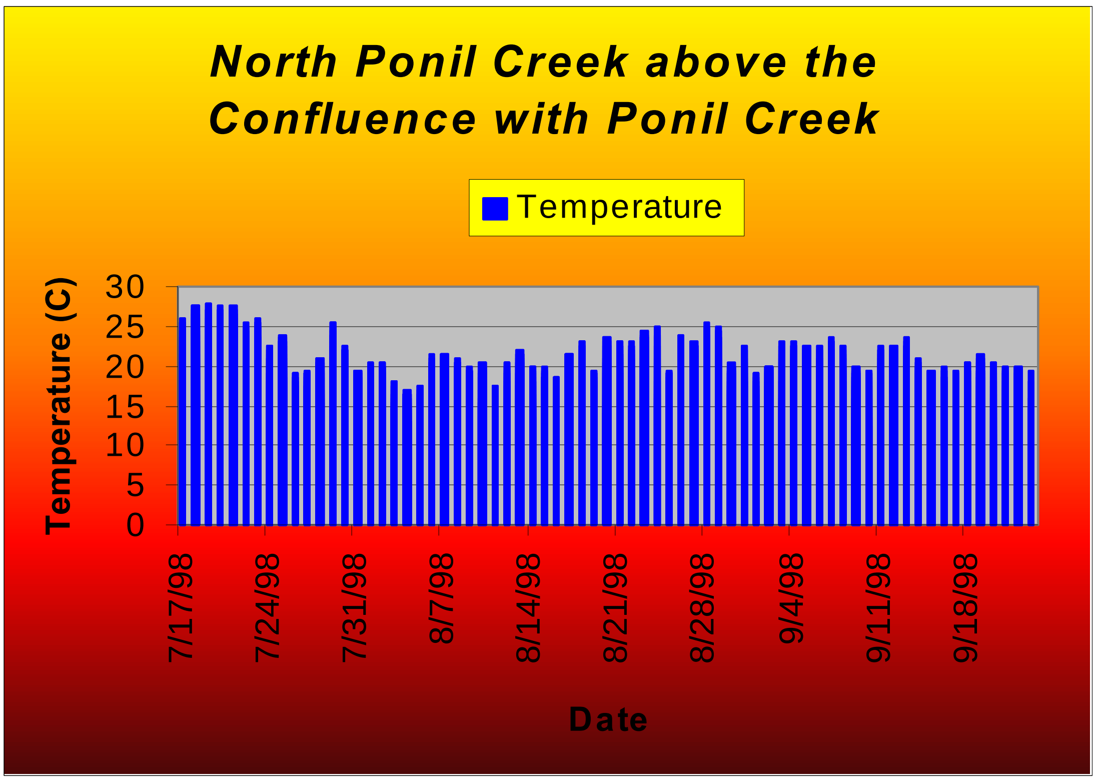
McCrystal Creek (Upper North Ponil) Above FR 1950 Cross Section 10/6/98



THALWAG = the thread of the deepest water; **SINUOSITY** = stream length/valley length or valley slope/channel slope; E**NTRENCHMENT RATIO** = the degree of vertical containment of a river channel (width of the flood prone area at an elevation twice the maximum bankfull depth/bankfull width; **W/D RATIO** = the shape of the channel cross-section (ratio of bankfull width/mean bankfull depth); **SLOPE** = slope of the water surface averaged for 20-30 channel widths

Lower North Ponil Thermograph Data

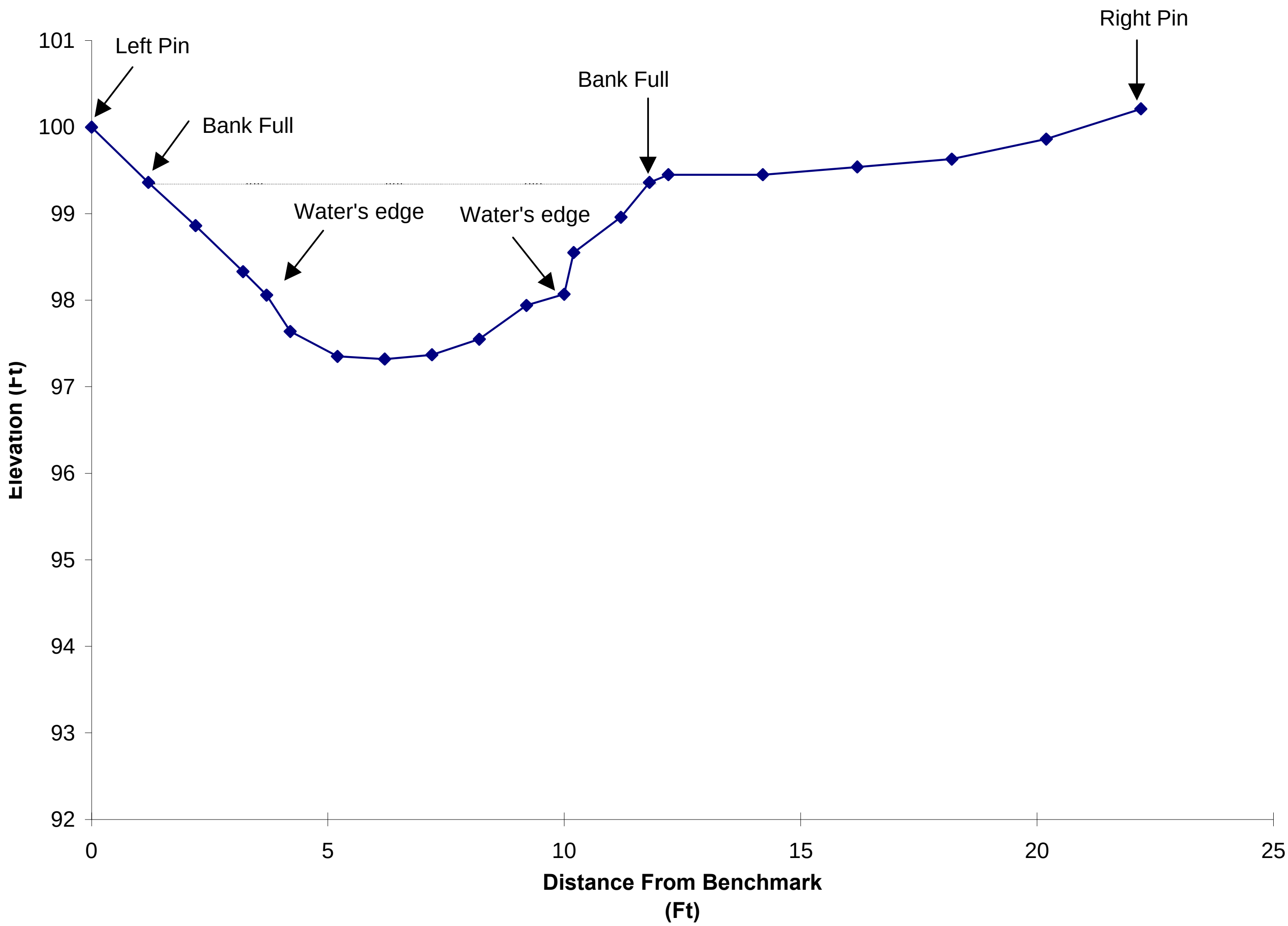
Total Readings	1632
Max. Temp.	28
# Values >20	***339***
% Values >20	***20.8***
Avg. Temp.	17.7
Min. Temp.	10.5
Variance	10.4



Each bar on the graph represents the 24-hour maximum temperature on each day, not the entire data set of 1,632 (i.e. 28°C on 7/19/98).

Lower North Ponil Thermograph Site

Lower North Ponil Creek Above Ponil Creek Cross Section 10/7/98



THALWAG = the thread of the deepest water; **SINUOSITY** = stream length/valley length or valley slope/channel slope; E**NTRENCHMEN** **RATIO** = the degree of vertical containment of a river channel (width of the flood prone area at an elevation twice the maximum bankfull depth/bankfull width; **W/D RATIO** = the shape of the channel cross-section (ratio of bankfull width/mean bankfull depth); **SLOPE** = slope o the water surface averaged for 20-30 channel widths

Appendix B SSTEMP Model Outputs

Upper North Ponil Creek

SSTEMP V3 6 08-24-1999 10:15:32

Run #1

0.100	Segment Inflow	cfs
57.560	Inflow Temperature	°F
0.100	Segment Outflow	cfs
50.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8700.000	Elevation Upstream	ft
8250.000	Downstream	ft
3.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
77.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
687.460	Solar Radiation	Langleys
13.980	Daylight Length	hr
31.000	Segment Shading	%
50.000	Ground Temperature	°F
0.000	Dam at Inflow (Yes=1 No=0)	

Minimum 24-hour temperature	52.33°F
Mean 24-hour temperature	62.91°F
Maximum 24-hour temperature	75.67°F

SSTEMP V3 6 08-24-1999 10:16:18

Run #2

0.100	Segment Inflow	cfs
57.560	Inflow Temperature	°F
0.100	Segment Outflow	cfs
50.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8700.000	Elevation Upstream	ft
8250.000	Downstream	ft
3.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	

77.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
687.460	Solar Radiation	Langleys
13.980	Daylight Length	hr
43.000	Segment Shading	%
50.000	Ground Temperature	°F
0.000	Dam at Inflow (Yes=1 No=0)	

Minimum 24-hour temperature	51.73°F
Mean 24-hour temperature	61.25°F
Maximum 24-hour temperature	70.77°F

SSTEMP V3 6   08-24-1999   10:16:53

Run #3

0.100	Segment Inflow	cfs
57.560	Inflow Temperature	°F
0.100	Segment Outflow	cfs
50.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8700.000	Elevation Upstream	ft
8250.000	Downstream	ft
3.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
77.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
687.460	Solar Radiation	Langleys
13.980	Daylight Length	hr
54.000	Segment Shading	%
50.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	51.24°F
Mean 24-hour temperature	59.69°F
Maximum 24-hour temperature	68.14°F

SSTEMP V3 6   08-24-1999   10:16:59

Run #4

0.100	Segment Inflow	cfs
57.560	Inflow Temperature	°F
0.100	Segment Outflow	cfs
50.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8700.000	Elevation Upstream	ft
8250.000	Downstream	ft
3.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
77.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
687.460	Solar Radiation	Langleys
13.980	Daylight Length	hr
55.000	Segment Shading	%
50.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	51.20°F
Mean 24-hour temperature	59.54°F
Maximum 24-hour temperature	67.89°F

SSTEMP V3 6   08-24-1999   10:17:06

Run #5

0.100	Segment Inflow	cfs
57.560	Inflow Temperature	°F
0.100	Segment Outflow	cfs
50.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8700.000	Elevation Upstream	ft
8250.000	Downstream	ft
3.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
77.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
687.460	Solar Radiation	Langleys

13.980	Daylight Length	hr
60.000	Segment Shading	%
50.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	50.99°F
Mean 24-hour temperature	58.81°F
Maximum 24-hour temperature	66.63°F

Lower North Ponil Creek

SSTEMP V3 6   08-24-1999   15:21:04

Run #1

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
36.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	52.68°F
Mean 24-hour temperature	62.93°F
Maximum 24-hour temperature	73.18°F

SSTEMP V3 6   08-24-1999   15:21:22

Run #2

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
40.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow (Yes=1 No=0)	

Minimum 24-hour temperature	52.55°F
Mean 24-hour temperature	62.43°F
Maximum 24-hour temperature	72.30°F

SSTEMP V3 6   08-24-1999   15:21:37

Run #3

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%

680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
45.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	52.40°F
Mean 24-hour temperature	61.79°F
Maximum 24-hour temperature	71.19°F

SSTEMP V3 6 08-24-1999 15:21:55

Run #4

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
50.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	52.27°F
Mean 24-hour temperature	61.16°F
Maximum 24-hour temperature	70.04°F

SSTEMP V3 6   08-24-1999   15:22:11

Run #5

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
55.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow (Yes=1 No=0)	

Minimum 24-hour temperature	52.15°F
Mean 24-hour temperature	60.51°F
Maximum 24-hour temperature	68.87°F

SSTEMP V3 6   08-24-1999   15:22:26

Run #6

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%

680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
59.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	52.07°F
Mean 24-hour temperature	59.99°F
Maximum 24-hour temperature	67.90°F

SSTEMP V3 6 08-24-1999 15:22:42

Run #7

0.100	Segment Inflow	cfs
63.860	Inflow Temperature	°F
0.410	Segment Outflow	cfs
55.000	Lateral Temperature	°F
5.000	Segment Length	mi
0.035	Manning's n	
8250.000	Elevation Upstream	ft
7250.000	Downstream	ft
10.000	Width's A Term	
0.200	B Term where W = A*Q**B	
1.650	Thermal Gradient j/m²/s/c	
79.000	Air Temperature	°F
10.000	Relative Humidity	%
8.000	Wind Speed	mph
85.000	Percent Possible Sun	%
680.760	Solar Radiation	Langleys
14.030	Daylight Length	hr
64.000	Segment Shading	%
55.000	Ground Temperature	°F
0.000	Dam at Inflow	(Yes=1 No=0)

Minimum 24-hour temperature	51.98°F
Mean 24-hour temperature	59.33°F
Maximum 24-hour temperature	66.68°F

Appendix C Critical Low Flow Model Outputs

Estimated 4Q3 flow for Upper North Ponil Creek

It is often necessary to calculate a critical flow for a portion of a watershed where there is no stage gage. This can be accomplished by applying one of two formulas developed by the USGS. One formula (Waltemeyer 1987) is recommended when the ratio between the two watershed areas is between 0.5 and 1.5. The other formula, to be used when the watershed ratio is outside this range, is a regression formula also developed by the USGS (Borland 1970).

Where:

A_g = Drainage area above the gage in question
A_u = Watershed size above the area of interest
P_a = Mean October through April precipitation in inches
R = Ratio of $Q_{4/3}$ /$Q_{7/2}$

1). The nearest gage to the point of interest is Ponil Creek near Cimarron (07207500). The drainage area above this gage (A_g) is 171 mi^2. The watershed above the area of interest (A_u) is 16 mi^2. The ratio of water shed size (16/171) is 0.09. Using guidelines recommended by USGS when this value is less than 0.5 we apply the formula as shown in step 2.

A_u = 16 mi^2
P_a = 9.6

2) Applying the formula the calculated 7Q2 is:

$Q_{7/2} = 1.36x10^{-4} \text{ x } (A_u)^{0.566} \text{ x } (P_a)^{3.22}$
$Q_{7/2} = 1.36x10^{-4} \text{ x } (16)^{0566} \text{ x } (9.6)^{3.22}$
$Q_{7/2}$ = 0.95cfs

3) Multiply the ratio factor from step 1 (0.09) by the 7Q2 flow calculated in step 2 (0.34 cfs) to get an estimate of the 4Q3 flow for this point in the watershed.

0.95 cfs x 0.09 = .086

4) The 1-day, 3-day, and 7-day low flow events are shown on the attached table. The $Q_{4/3}$ low flow is 0.29 cfs. The $Q_{7/2}$ is 3.63 cfs.

The ratio of $Q_{4/3}$ (.29 cfs) /$Q_{7/2}$ (3.63 cfs) R = 0.08

5) Multiplying the ratio(0.08) from step 4 times the $Q_{7/2}$ flow (.95 cfs) in step 2 we get:

$Q_{4/3(est)} = R\ (Q_{7/2})$
$Q_{4/3(est)} = 0.08\ (.95\ cfs)$
$\mathbf{Q_{4/3(est)} = 0.08\ cfs}$

Model Verification

In order to validate the model, the Log Pearson Type III $Q_{4/3}$ based on empirical data at Ponil Creek near Cimarron (07207500) gage was calculated using Hydrotech® software. This value was 3.63 cfs. The formula derived $Q_{4/3\ (est)}$ for this gage as calculated below was 0.29 cfs.

A_g = $171\ mi^2$
P_a = 9.6 in
R = 0.08
$Q_{7/2}$ = $1.36 x 10^{-4} \times (A_g)^{0.566} \times (P_a)^{3.22}$
$Q_{7/2}$ = $1.36 x 10^{-4} \times (171)^{0.566} \times (9.6)^{3.22}$
$Q_{7/2}$ = 3.63 cfs

$Q_{4/3(est)}$ = $R\ (Q_{7/2})$
$Q_{4/3(est)}$ = 0.08 (3.63 cfs)
$Q_{4/3(est)}$ = 0.29 cfs

The formula estimated value of .29 cfs and the statistically derived value 3.63 cfs are then compared to calculate a % error between the estimated and statistically derived values.

% Error = $((Q_{4/3} - Q_{4/3\ (est)}) / Q_{7/2}) * 100$
% Error = ((0.28 cfs - .29 cfs) / 3.63 cfs) * 100
% Error = - 0.27 %

UPPER NORTH PONIL 4Q3 CALCULATION

Years	1-day flow	3-day flow	7 day flow
10	0	0	0
5	0	0	0
2	0.1	0.2	0.2

Ag =	171
Au =	16
Pa =	9.6
4Q3/7Q2 =	0.22
7Q2 =	3.633524
Gaged 4Q3 =	0.29
4Q3 =	0.075867
Est 4Q3 =	0.799375

EAGLE NEST OCTOBER THROUGH APRIL PRECIPITATION 1980-1997

NUMBEF	LOCATION			STATE	**YEAR**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**ANNUAL**
292700	EAGLE	NE	ST	NM	1980	50	56	20	115	70	94	207	**612**
292700	EAGLE	NE	ST	NM	1981	53	35	18	12	5	93	41	**257**
292700	EAGLE	NE	ST	NM	1982		114	79	137	189	127	25	**671**
292700	EAGLE	NE	ST	NM	1983	27	66	129					**222**
292700	EAGLE	NE	ST	NM	1984	215	12	156	52	53	103	50	**641**
292700	EAGLE	NE	ST	NM	1985	229	59	21	59	28	294	240	**930**
292700	EAGLE	NE	ST	NM	1986	114	126	84	39	56	51	252	**722**
292700	EAGLE	NE	ST	NM	1987	32	48	59	113	177	169	46	**644**
292700	EAGLE	NE	ST	NM	1988	39	81	48	66	78	55	133	**500**
292700	EAGLE	NE	ST	NM	1989	251	0	106	123	324	54	44	**902**
292700	EAGLE	NE	ST	NM	1990	48	124	221	64	111		83	**651**
292700	EAGLE	NE	ST	NM	1991	87	123	96	17	39	162	18	**542**
292700	EAGLE	NE	ST	NM	1992	5	58	74		18	125	0	**280**
292700	EAGLE	NE	ST	NM	1993	139	76		60		46	165	**486**
292700	EAGLE	NE	ST	NM	1994	187	119	114	37	103	495		**1055**
292700	EAGLE	NE	ST	NM	1995	0	20	31	60	86		218	**415**
292700	EAGLE	NE	ST	NM	1996	176	123	13					**312**
292700	EAGLE	NE	ST	NM	1997	73	105	58	126		59	219	**640**
Total Monthly Precipitation (inches)						**5777**	**4725**	**3750**	**4223**	**3722**	**5623**	**5902**	**33722**
Average Monthly Precipitation (inches)						**101.5**	**74.72**	**78.06**	**72**	**95.5**	**137.6**	**116.1**	**560.13**
Average October through April Precipitation (inches)													**96.4945**

Estimated 4Q3 flow for Lower North Ponil Creek

It is often necessary to calculate a critical flow for a portion of a watershed where there is no stage gage. This can be accomplished by applying one of two formulas developed by the USGS. One formula (Waltemeyer 1987) is recommended when the ratio between the two watershed areas is between 0.5 and 1.5. The other formula, to be used when the watershed ratio is outside this range, is a regression formula also developed by the USGS (Borland 1970).

Where:

A_g = Drainage area above the gage in question
A_u = Watershed size above the area of interest
P_a = Mean October through April precipitation in inches
R = Ratio of $Q_{4/3}$ /$Q_{7/2}$

1) The nearest gage to the point of interest is Ponil Creek near Cimarron (07207500). The drainage area above this gage (A_g) is 171 mi^2. The watershed above the area of interest (A_u) is 75 mi^2. The ratio of water shed size (75/171) is 0.44. Using guidelines recommended by USGS when this value is less than 0.5 we apply the formula as shown in step 2.

   A_u = 75 mi^2
   P_a = 7.7

2) Applying the formula the calculated 7Q2 is

   $Q_{7/2}$ = $1.36 \times 10^{-4} \times (A_u)^{0.566} \times (P_a)^{3.22}$
   $Q_{7/2}$ = $1.36 \times 10^{-4} \times (75)^{0.566} \times (7.7)^{3.22}$
   $Q_{7/2}$ = 1.12 cfs

3) Multiply the ratio factor from step 1 (0.44) by the 7Q2 flow calculated in step 2 (1.12 cfs)

   1.12 cfs x 0.44 = 0.49

4) The 1-day, 3-day, and 7-day low flow events are shown on the attached table. The $Q_{4/3}$ low flow is 0.80 cfs. The $Q_{7/2}$ is 2.19 cfs

   The ratio of $Q_{4/3}$ (0.80 cfs) /$Q_{7/2}$ (2.19 cfs) R = 0.37.

5) Multiplying the ratio (0.37) from step 3 times the $Q_{7/2}$ flow (1.12 cfs) in step 2 we get:

   $Q_{4/3(est)}$ = R ($Q_{7/2}$)
   $Q_{4/3(est)}$ = 0.37 (1.12 cfs)
   $Q_{4/3(est)}$ = 0.41 cfs

Model verification

In order to validate the model, the Log Pearson Type III $Q_{4/3}$ based on empirical data at Ponil Creek near Cimarron (07207500) gage was calculated using Hydrotech® software. This value was 2.19 cfs. The formula derived $Q_{4/3\ (est)}$ for this gage as calculated below was 0.65 cfs.

A_g = 171 mi^2
P_a = 7.7 in
R = 0.37
$Q_{7/2}$ = $1.36 \times 10^{-4} \times (A_g)^{0.566} \times (P_a)^{3.22}$
$Q_{7/2}$ = $1.36 \times 10^{-4} \times (171)^{0.566} \times (7.7)^{3.22}$

$Q_{7/2}$ = 1.78 cfs

$Q_{4/3(est)}$ = R ($Q_{7/2}$)
$Q_{4/3(est)}$ = 0.37 (1.78 cfs)
$Q_{4/3(est)}$ = 0.65 cfs

The formula estimated value of 1.10 cfs and the statistically derived value 2.19 cfs are then compared to calculate a % error between the estimated and statistically derived values.

% Error = (($Q_{4/3}$ - $Q_{4/3\ (est)}$) / $Q_{7/2}$) * 100
% Error = ((0.80 cfs - 0.65 cfs) / 2.19 cfs) * 100
% Error = 6.8 %

Lower North Ponil Creek 4Q3 Calculation

Years	1-day flow	3-day flow	7 day flow
10	0	0	0
5	0	0	0
2	0.1	0.2	0.2

Ag =	171
Au =	75
Pa =	7.7
4Q3/7Q2 =	0.37
7Q2 =	2.190604
Gaged 4Q3 =	0.8
4Q3 =	0.501763
Est 4Q3 =	0.810524

CIMARRON OCTOBER THROUGH APRIL PRECIPITATION 1980-1997

NUMBEF	LOCATI ON		STATE	**YEAR**	**OCT**	**NOV**	**DEC**	**JAN**	**FEB**	**MAR**	**APR**	**ANNUAL**
291813	CIMARR ON	4 SW	NM	1980	0		0	60	0	60	356	476
291813	CIMARR ON	4 SW	NM	1981	32	10	0	5		106	61	214
291813	CIMARR ON	4 SW	NM	1982	19	75			55	23	22	194
291813	CIMARR ON	4 SW	NM	1983	25	3	66	163	54	119		430
291813	CIMARR ON	4 SW	NM	1984	263	24	70		29	124	51	561
291813	CIMARR ON	4 SW	NM	1985	199	11	9	126	52	200	221	818
291813	CIMARR ON	4 SW	NM	1986	319	193	60	26	77	63	93	831
291813	CIMARR ON	4 SW	NM	1987	12	43	96	145	286	87	82	751
291813	CIMARR ON	4 SW	NM	1988	54	94	28	45	5	44	151	421
291813	CIMARR ON	4 SW	NM	1989	167	6	87	36	108	4	22	430
291813	CIMARR ON	4 SW	NM	1990	26	116	37	122	158	92	144	695
291813	CIMARR ON	4 SW	NM	1991	39	200		8	19	67	18	351
291813	CIMARR ON	4 SW	NM	1992	15		79		0	42	19	155
291813	CIMARR ON	4 SW	NM	1993	50	121		37	87	78	101	474
291813	CIMARR ON	4 SW	NM	1994	182	68	1	30	47	214	162	704
291813	CIMARR ON	4 SW	NM	1995	0	94	33	10	55	94	224	510
291813	CIMARR ON	4 SW	NM	1996	145	80	43	19	42	22	0	351
291813	CIMARR ON	4 SW	NM	1997		58	63	86	122	11	325	665
Total Yearly Precipitation					**1547**	**1196**	**672**	**918**	**1196**	**1450**	**2052**	**9031**
Average Yearly Precipitation					**91**	**74.75**	**44.8**	**61.2**	**70.3529**	**80.5556**	**120.706**	**543.364**
Average October through April Precipitation (inches)												**77.6235**

Appendix D Public Comments

Gilbert Vigil, Forest Supervisor, Carson National Forest, Taos, NM
Received 10/12/99

The Bureau would like to thank the Carson National Forest for taking the time to comment on this document.

Page 1, second paragraph, the following statement is made:

C: “Over the years, reduced riparian vegetation, including herbaceous woody plants such as willow, narrowleaf cottonwood or alder along the stream, and exceedances in temperature standards have been seen and documented along this reach of North Ponil Creek.”

Do you intend to make available the documentation cited in the above sentence as part of this TMDL document? Is the upper North Ponil thermograph monitoring site one of the locations that have been documented as exceeding the temperature standard in the past.

R: The above stated language will be changed to the following, “In 1996, the United States Forest Service, Carson National Forest removed a fishing pond below McCrystal Creek Campground that had been established some years earlier. It appears that the stream was not restored to its natural geomorphic conditions (pre-fishing pond), therefore causing serious erosion, sediment deposition downstream, slumping and streambank destabilization throughout the system. The loss of streambank and thus riparian vegetation (including streamside grasses), increased width-to-depth ratios, and could lead to direct solar gain during the critical summer months. As far back as June 6, 1989 temperature exceedences have been documented at this upper site (22.1°C) as well as the lower site on June 5, 7 and 8, 1989 (22.8°, 24.1°C, 23.0° and 20.1°C) respectively.”

C: Given the results of your thermograph monitoring on the upper North Ponil site as displayed in Appendix A (44 exceedances out of 1631 readings or 2.7 percent of the total) and the photograph of the monitoring site and its physical setting, one could question if this particular site is impaired for temperature, especially given an average temperature of 14.2 degrees Celsius, which is well below the 20 degree Celsius standard.

R: The temperature standard for this segment (2306) is 20°C (68°F) (needing only to be exceeded once for any period of time). A **Draft** Temperature Protocol has been developed by a workgroup consisting of staff from the New Mexico Environment Department, Surface Water Quality Bureau, New Mexico Department of Game & Fish, US Fish & Wildlife and USEPA Region 6 to provide more flexibility with the standard and still protect the fishery in a conservative manner. The following is the recommendation from the workgroup for a HQCWF:

Temperature in High Quality Coldwater Fisheries (HQCWF)

Full Support Instantaneous (hourly) temperatures do not exceed 23.0°C and temperatures do not exceed 20.0°C for more than four hours in a 24-hour cycle, and for no more than three consecutive days.

Partial Support Instantaneous (hourly) temperatures do not exceed 23.0°C. Temperatures may exceed 20.0°C for greater than four, but no more than six, hours in a 24-hour cycle, and for no more than three consecutive days.

Not Supported Instantaneous (hourly) temperatures exceed 23.0°C, or temperatures exceed 20°C for more than six hours in a 24-hour cycle, or the allowable interval is exceeded for more than three consecutive days.

Using these criterion, the field data showed the following:

20°C was exceeded for more than six hours, and is considered ***Not Supporting*** its designated use.

Date/Time	Temperature °C
7/18/1998 13:59	***20.5***
7/18/1998 14:59	***22.5***
7/18/1998 15:59	***23***
7/18/1998 16:59	***23***
7/18/1998 17:59	***23***
7/18/1998 18:59	***22.5***
7/18/1998 19:59	***21.5***
7/18/1998 20:59	***20.5***

C: Page 13, Three Month Summer Model Run On Upper Ponil Creek June through August

Several questions arise from the information presented in this table.

1. The model run dates column indicates a sampling date of June 1 thru August 31. The bar graph for the Upper Ponil site cites dates ranging from July 17 thru August 23.

Do these date ranges overlap between the monitored temperature data and the modeled temperatures?

Are the temperature values listed under the column "Temperature degrees Celsius" those generated by the model or values extracted from the monitored stream temperature data from this location?

R: The model run from June through August was chosen due to the historically higher ambient air temperatures during this time of the year as well as lower flow conditions and the ability of the receiving water to assimilate direct solar gain without exceeding the surface water temperature standard of 20°C. Under the "Temperature degrees Celsius" column on page 13, the values are those generated by the model predicated on the percent total shade to the stream.

2. If these temperature values are modeled, are you concerned that the maximum, minimum and mean displayed in this table are so much different from those same temperature values (maximum, minimum and average) generated by the collection of the actual stream temperature data during a similar period of time? For example, the table on page 13 shows a minimum temperature of 11.29 degrees Celsius but the bar graph statistics contained in Appendix A shows a minimum temperature of 6.5 degrees Celsius.

R: The individual field readings are not modeled. What is modeled is the amount of topographic and vegetative shade that is needed to maintain a 20°C surface water temperature standard on a 24-hour basis 365 days a year. The minimum temperature on page 13 (11.29°C) is an output from the model with the current condition inputs. The maximum temperature from the same model run produced a value of 23.04°C and the statistics in Appendix A show a maximum temperature value of 23°C. Adjustment of the model is a possibility but does not guarantee exact matches with the actual field data.

3. Which will take precedence in determining compliance with water quality standards, temperature data actually collected or modeled temperatures as shown in the table?

R: Temperature data actually collected. The temperature standard for this segment (2306) is 20°C (68°F). The **Draft** Temperature Protocol referenced above will be followed to determine if water quality standards are being met.

References Cited

US EPA. 1993. ***Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.*** EPA-840-B-92-002. Washington, D.C.

NMWQCC 1994. ***New Mexico Nonpoint Source Management Plan.*** Section 319(b)(1) federal Clean Water Act.

New Mexico Water Quality Control Commission, ***State of New Mexico Standards for Interstate and Intrastate Streams***

US Geological Survey, Biological Resource Division, Midcontinent Ecological Science Center, River Systems Management Section, Fort Collins, CO, 1997. ***The Stream Segment and Stream Temperature Models, Version 1.0***

US Geological Survey 1996. ***Analysis of the Magnitude and Frequency of Peak Discharge and Maximum Observed Peak Discharge in New Mexico***. Water-Resources Investigations Report 96-4112

US EPA, James M Omernik. ***Ecoregions of the South Central States***. Environmental Research Laboratory, Corvallis, Oregon.